A first look at the quantification capabilities of the prototype Mars 2020 Planetary Instrument for X-ray Lithochemistry

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The Mars 2020 rover's Planetary Instrument of X-ray Lithochemistry (PIXL) is a focused micro-beam x-ray fluorescence (XRF) instrument that will provide the first ever *in situ* sub-millimeter resolution maps of Martian rocks and soils. These centimeter scale maps will enable scientists to correlate rock chemistry to fine scale visible textures, enabling detailed investigation of past geological processes and potential for ancient biosignatures. To make the most of PIXL's XRF mapping capabilities, it is essential to produce quantitative measurements of individual rock components captured in a map. These quantitative measurement capabilities are currently being refined.

Two of the key challenges confronting improvement of PIXL's quantitative measurement capability are discussed here. The first challenge relates to the micro-scale heterogeneity of powdered standards needed to characterize quantification accuracy when the X-ray beam is focused on different elemental matrixes. The short attenuation lengths of light elements and the small diameter of the focused X-ray beam necessitate intimate knowledge of the degree to which each powder approximates a homogeneous matrix, and places limits on measurement accuracy. The second challenge relates to short per-spot integration times (due to constrained experiment times), which presents statistical limitations on the accuracy of quantification of the smallest rock components. Both challenges have been examined in this work.

Calibration of the PIXL system commenced with measurements of standards using a prototype instrument featuring two Ketek detectors and a Moxtek Rh X-ray tube coupled to an XOS polycapillary transmission optic. XRF data processing was performed using in-house PIQUANT software. Accuracy of measurements are reported for standards: BHVO-2, BCR-2 and BIR-1 in both glass and powder form, using short and long measurement integration times. System performance in quantifying major and minor element-oxide constituents found in silicate materials was assessed at the long and short integration times. XRF quantification results are compared between powder and glass standards, and provide a first look at what differences might be expected when pressed powders are used in calibration protocols.